Subject: Regarding FCC Noise Floor Technical Inquiry - ET Docket No. 16-191

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My comments and responses to your questions about radio spectrum noise floor.

We are looking for responses to the following questions to help us identify aspects of a study to determine trends in the radio spectrum noise floor.
1. Is there a noise problem?

Yes

a. If so, what are the expected major sources of noise that are of concern?

-Switching power supplies
-Transformers
-Ungrounded digital devices (routers, modems, TVs, computers)
-Smart meters (RF and noise from switching power supplies)
-Variable speed motors
-GFCI outlets
-Dimmer switches
-Compact fluorescent lights
-LED lights
-Communication over power lines
-Insufficient electrical return capacity
- ground current running on earth back to the electrical substation.
-Shared neighbor ground via metal water pipes, cable, telephone becomes a noise distribution network.

b. What services are being most impacted by a rising spectrum noise floor?

Electrical power quality is being reduced by higher levels of RF devices--both residential (Wi-Fi) and commercial (cell towers). Switching power supplies and other noise from the devices is impacting the electrical power supply in the same area. Most residential Wi-Fis are not grounded (which could reduce noise), and commercial cell tower frequencies create so much noise on the local electrical grid that they create measurable ground currents in the area around the tower. Having noise on the ground makes it harder to create a clean signal.

Audio engineers and technicians are complaining about regressions in power quality (more microsurges, etc) and failure of electronic equipment. This cost is held by consumers and businesses and it makes it hard for companies to calculate warranty costs when noise and surge levels are not measured and are rising. Noel Lee,president of Monster (http://www.monsterproducts.com/company/about-monster), discusses this in a video that comes with his monster power products.

Increasing noise is most commonly addressed by increasing signal, which uses more power. The most efficient long term strategy for maintaining clear communication is to measure and manage both signal and noise levels to maximize signal-to-noise ratio with minimal cost and power consumption. As communication increases and becomes a larger piece of our power consumption, addressing noise is required for clear communication and reduction in greenhouse gases.

In real estate, properties near a freeway or airport have less value because of the noise impact on residents. Spectrum licenses with lower noise levels should yield a higher auction value. Conversely, if telecom pays billions of dollars for frequency bands, are they entitled to some sort of protection from noise and interference on that band? I would think that investment by the FCC in monitoring noise nationally by band and location would be part of full disclosure at bandwidth auctions.

c. If incidental radiators are a concern, what sorts of government, industry, and civil society efforts might be appropriate to ameliorate the noise they produce?

I would also add the military as a contributor to this equation. Many electronic warfare tactics for measuring and blocking communication of enemy signals would likely use noise transmission to block clear communication. Technology already developed for the military could be used or licensed to commercial ventures.

NASA is another potential partner here. Noise reduction in spacecraft is a key element to long range communication. The SETI project and its search for signs of intelligent life would certainly have algorithms to measure natural noise and intelligent signals.

The Green Bank radio telescope project with its RF “Quiet Zone” would be a good source of information about man-made RF interference.

I would also include the Department of Energy, because increases in noise in the underlying power grid without power conditioning or noise reduction, will be translated into increased or even amplified noise in RF. My contact at the FCC informs me that this is not being monitored by DOE. This is not only a major potential source of noise for RF, but a problem that undermines the efficiency of the power grid, shifting the power factor of the lines to a more capacitive state, increasing line loss and lowering the efficiency of the power grid. There are no financial incentives in place to monitor or improve electrical power quality.

Consumers are paying for 60hz, but frequently get large amounts of harmonics, noise, and RF. Also, power companies are forced to reimburse solar and wind customers for power that is usually lower quality (large amount of micro-surges and RF from inverters). Very few people are measuring and attempting to manage this. Electrical services with less noise should command a greater commercial value, like all other commodities. Electrical standards may need to change to account for the higher noise and high frequency capacity from today's digital devices. Electrical grounding systems may need to be designed more like radar grounding systems with more capacity and surface area for high frequency noise.

On several occasions, I have found radio and TV signals carried along on power in homes. (Measured with an AlphaLabs Power Line Meter https://www.trifield.com/content/power-line-meter/). There also seem to be no technology or residential or commercial code in place to prevent RF from being on the lines. What would prevent terrorists from putting microwave frequencies on a building's power? What technology would allow us to measure when that is happening unintentionally?

A commercial venture that could yield results would be something like the Netspot app for the Mac. The free application plots out a "heat map" of signal strength and also noise levels to help users improve their Wi-Fi signal. A multi-band antenna with software like this could help consumers and broadcasters improve signal quality.

Mapping companies like Google already have cars driving up and down streets in the US collection Wi-Fi data. They may already be collecting noise levels or other bands. I'm not sure how Netspot is calculating noise, but you may be able to make the calculation for the Wi-Fi band with existing data that has already been collected. If noise from power and reduced ground capacity are related to RF noise, the noise from Wi-Fi would be a decent heuristic for RF noise in general across the spectrum, since those underlying factors are shared by all transmitters in the area. Even if current data can't be used, this would be an inexpensive way to create a nationwide RF noise map. Since multiple mapping companies are doing this, bidding it to several companies would also reduce costs.

2. Where does the problem exist?
a. Spectrally

The Wi-Fi working group is complaining of interference and overlap in the 2.4Ghz band. Reducing noise in this band would allow for good signal quality with lower power and reduced overlap of signals (lower range). Lower signal overlap would then create less signal to signal interference. Lower range would also help make Wi-Fi more secure.

i. What frequency bands are of the most interest?

Frequency bands that contain resonant frequencies of metallics components of wiring and electronics may be an issue. This is not just for transmitting and receiving equipment, but for medical devices like pacemakers and other implants (titanium used for hip implants and for dental implants). It's also important to check for resonant frequencies of the metals in an oxidized state (for instance, oxidized copper).

Frequency bands that contain resonant frequencies of water and Co2 and other heat sensitive gases, liquids, and solids that could contribute to increased temperature should be examined to determine how much noise and signals in those bands contribute directly to global warming.

b. Spatially

Cellular antennas have, in some cases, created noise on electrical lines. If those are the same electrical lines that power the antenna, there could be a "feedback" loop of noise similar to when a microphone gets too close to a speaker.

i. Indoors vs. outdoors?

Lower humidity levels create environments more prone to static electricity, a contributing noise factor.

ii. Cities vs. rural settings?

Noise producing devices in densely populated areas may exceed the capacity of ground rods and the soil's capacity to distribute noise. Earth or "ground" is not an unlimited resource and soil's resistance of the ground wiring may limit the ability of grounding systems to "drain" noise from a device. Surface area and the oxidative state of the wiring will limit the amount of noise and which frequencies can travel on the wire.

iii. How close in proximity to incidental radiators or other noise sources?

This depends on power levels, field levels, shielding, and ground resistance. Each case will need to be tested.

iv. How can natural propagation effects be accounted for in a noise study?

c. Temporally
i. Night versus day?
ii. Seasonally?

You should see changes in noise levels related to soil moisture and groundwater levels. Dryer soil lowers conductivity of ground rods, which are a primary source of dissipating noise. Droughts in areas like California will likely increase noise levels, especially in the summer.

3. Is there quantitative evidence of the overall increase in the total integrated noise floor across various segments of the radio frequency spectrum?
a. At what levels does the noise floor cause harmful interference to particular radio services?
b. What RF environment data from the past 20 years is available, showing the contribution of the major sources of noise?

My understanding is that the last nationwide RF environmental survey was around 1980. If these surveys were still in place, you wouldn't have to publicly ask for input--you would have the data and the FCC would have some control of the situation. I believe this was done by the EPA at one point, but was de-funded.

c. Please provide references to scholarly articles or other sources of spectrum noise measurements.

Electric Power Waveform Distortion

http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001025390

Assessment of New and Advanced Power Quality Measurement Devices and the Omicron Power Quality Test Module

http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002005972

EPRI study?

4. How should a noise study be performed?
a. What should be the focus of the noise study?
b. How should it be funded?
c. What methods should be used?
d. How should noise be measured?
i. What is the optimal instrumentation that should be used?
ii. What measurement parameters should be used for that instrumentation?
iii. At what spatial and temporal scales should noise be measured?
iv. Should the monitoring instrumentation be capable of determining the directions of the noise sources? If so, how would those data be used?
v. Is there an optimal height above ground for measurements?
e. What measurement accuracy is needed?

i. What are the statistical requirements for sufficient data? Would these requirements vary based on spectral, spatial, and temporal factors?
ii. Can measurements from uncalibrated, or minimally calibrated, devices be combined?
iii. Is it possible to “crowd source” a noise study?
f. Would receiver noise measurements commonly logged by certain users (e.g. radio astronomers, cellular, and broadcast auxiliary licensees) be available and useful for noise floor studies?
g. How much data must be collected to reach a conclusion?

Start with some small cases and build up.

h. How can noise be distinguished from signals?

See previous comments about collaboration with SETI.

i. Can noise be characterized and its source identified?

In audio, noise in electrical power is also found in the sound output, reducing the signal quality. How much noise of the electrical wiring is found in the transmitted RF signal? I would estimate the most noise comes from noise on electrical power. Practices of sharing ground rods and bonding ground to water pipes and other metal infrastructure (cable, etc.) and even ground currents directly in soil make this extremely challenging to isolate the source of the problem.

ii. Is there a threshold level, below which measurements should be ignored?